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A STUDY OF THE IMPACT OF EXPANDING MOUNT HOPE AIRPORT

OCTOBER 26, 1970

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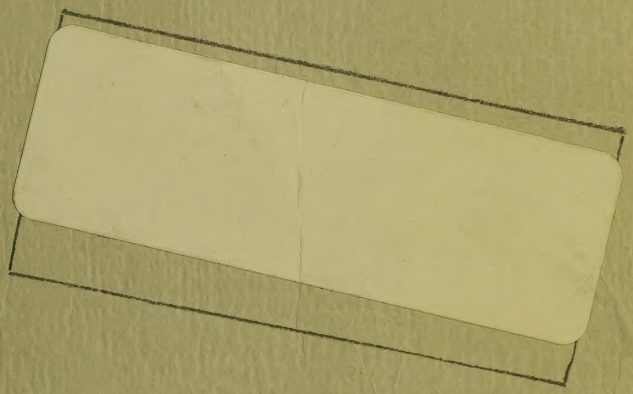

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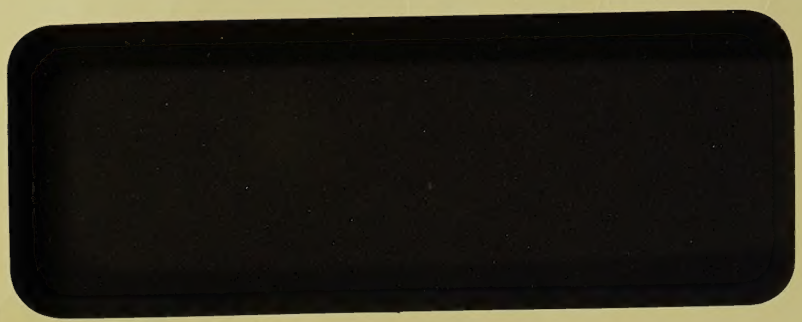

A STUDY OF THE IMPACT OF EXPANDING MOUNT HOPE AIRPORT

OCTOBER 26, 1970

A STUDY OF THE IMPACT OF EXPANDING MOUNT HOPE AIRPORT

For

HAMILTON ECONOMIC DEVELOPMENT COMMISSION

Prepared by F. Isbester
J. Betak
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October 26, 1970

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HAMILTON, ONTARIO

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FINDINGS

This report finds that:

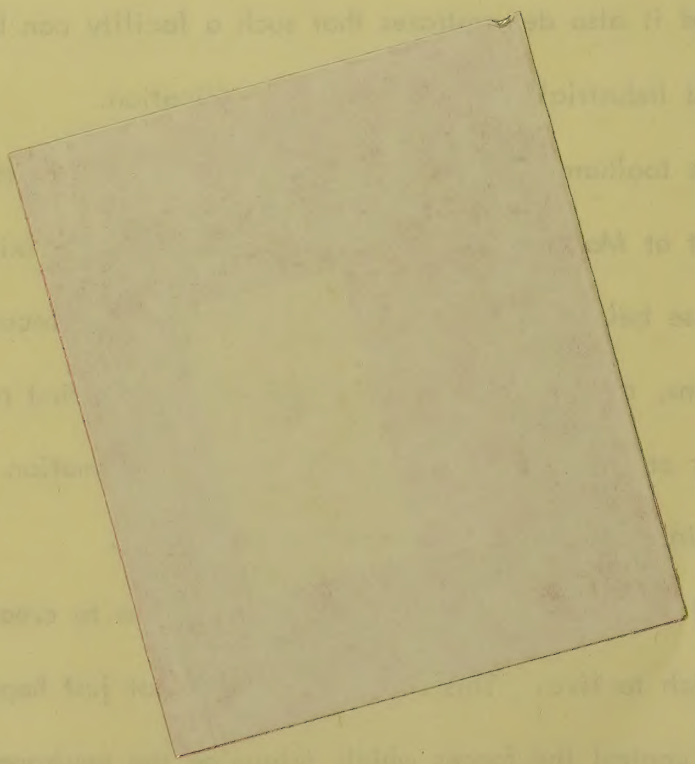
1. At current domestic users demand, metropolitan Hamilton can support a full-service, Department of Transport (D.O.T.), regional airport.
2. Such a facility would provide significant relief for Toronto International Airport.
3. Future domestic demand will easily support this facility.
4. A full-service, D.O.T. airport will have a substantial economic impact on the Hamilton metropolitan area.
5. Expansion of the Mount Hope facilities to a full-service, D.O.T., airport will have little or no deleterious effect upon surrounding land uses.
6. Pollution measuring devices should be installed at key positions in the airport vicinity to monitor major pollutants so that, if necessary, the utilization of the airport can be carefully controlled.
7. The impact of an airport is the same as that of any other major transportation facility; therefore, it must be integrated with the land use and community plans.

BACKGROUND TO THE STUDY

Some months previously it was tentatively proposed that Hamilton municipal airport at Mount Hope be expanded and improved to provide full aviation services to the city and to the region which it serves -- especially the areas to the South and South-West. To better understand the timeliness of this proposal, this report reviews the development of airports in general and Hamilton municipal airport in particular. It briefly elaborates the current situation and examines some of the implications of the proposal for a full-service facility. In particular the report demonstrates that a need now exists for a full-service domestic airport at Mount Hope and it also demonstrates that such a facility can be the catalyst for commercial and industrial expansion and diversification.

It would be foolhardy to continue this discussion of the proposed expansion of Hamilton airport at Mount Hope without acknowledging the existence of civic-minded groups whose beliefs and interests run contrary to the recommendations, tentative conclusions, and generalizations elaborated in the first report. Hopefully many of their anxieties may be overcome by the information contained in this report. Certainly, their ideas have not been ignored.

The general objective of all communities should be to create a favorable environment in which to live. This environment does not just happen; consequently there is a need to control the forces which determine the environment. One of the tools for bringing about the control of the environment is planning. This occurs through the creation of a physical framework in which the community may



eventually achieve its desired environment. The framework is generally created by: (1) allocating areas to industrial, commercial, and residential uses; and (2) establishing physical facilities to serve these areas; i.e., transportation, communications, power, water and sanitary facilities, and recreational facilities. Since airports are an important part of a community's transportation facilities, they must be properly incorporated in the framework for achieving the desirable environment.

The value of an airport to a community has been recognized not only by those who have a financial or professional interest in aviation but by the higher courts as well. Justice C. J. Cardozo of the New York Court of Appeals, in ruling for the City of Utica against a plaintiff who argued that the City did not have a right to issue corporate bonds to purchase land for establishment of an airport, noted:

> "Plaintiff argues that the acquisition of an airport or landing field is not a City purpose, even if a public one, and that the bonds, if issued, will be void. We think the purpose to be served is both public and municipal. A City acts for City purposes when it builds a dock or a bridge or a street or a subway. Its purpose is not different when it builds an airport. Aviation is today an established method of transportation. The future, even the near future will make it still more general. The City that is without the foresight to build the ports for the new traffic may soon be left behind in the race of competition. Chalcedon was called the City of the Blind because its founders rejected the nobler site of Bysantium lying at their feet. The need for vision of the future in the governance of cities has not lessened with the years. The dweller within the gates, even more the stranger from afar, will pay the price of blindness". [1]

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[1] Hesse -v- Rath et. al., New York Court of Appeals (249 N.Y. 436) December 7, 1928.

These words of Justice Cardozo were not written yesterday. The ruling was made in 1928 -- forty-two years ago.

Airport Development

To achieve this integration of the airport within the urban complex it is necessary to know and understand how the airport affects land surrounding it and vice versa, the requirements for airport siting and design, the requirements for airport support, and the importance of airports to urban areas and regions.

The effect of airports on urban form is many faceted. To assess all aspects it is first necessary to take a brief look at the history of airport growth. The pattern of development for most major airports has been historically similar. Approximately thirty years ago when airplanes were small in size and not very numerous, airport sites were selected where ground was cheap and few buildings were around to obstruct the approaches to the field. These criteria caused airports to be located at a distance from the city limits. There were few complaints of noise because it was generally infrequent and was not very loud. In fact, the noise which announced the arrival and departure of mail and passenger airplanes was often the source of much local pride.

Normal growth, plus wartime movement of people to the cities and the continued in-migration into the urban areas has caused a spreading out toward the airports. Often the activities of the airport acted as a magnet, first pulling the sightseer and then commercial interests out to the airport. Additionally, the land was cheap and associated with an advantageous type of transportation. This brought industry to locate near the airport.

The drawing of these enterprises also drew people, and these people needed homes that were reasonably close to their work. This brought out the speculator to subdivide the cheap land at a profit. This was possibly due to the availability of public utilities that had been primarily established to serve the airport. These public utilities were generally capable of handling the increased residential, commercial, and industrial demands. The result was an emergence of villages and towns, complete with shopping centers, schools, hospitals, and recreational facilities. Suddenly municipal airports which had started in open country were finding themselves progressively surrounded by commercial, residential, and industrial areas.

This historical trend has continued up to the present time, with more and more commercial, industrial, and residential development occurring in and around the airport areas. The biggest airport effect on the urban form is that of a magnet drawing development toward the airport site. This development, in turn, demands a ground transportation system to serve it and the airport. Additional public services are required, and then with the subsequent new services and transportation network new development and growth occurs in the airport area. This pattern is particularly prevalent around the continental and inter-continental airports, with the trunk and local airports experiencing the same condition to a lesser degree. As a result of this trend, two important conditions have arisen. The first is directly connected to the larger airports, this is the increasing problem of aircraft noise and safety factors affecting the surrounding and adjacent land uses.

The second situation is directly concerned with the local airports. These airports, faced with the increasing land values around them, are disappearing rapidly from the North American scene. The fact that they represent a sizable piece of open ground which is prime for development purposes (land that is fairly level and easy to develop at low construction costs), and because of the pressures of increased land values, have caused the demise of many of these important airports. This is especially true in the large metropolitan areas where growth and demand for land is ever upward in movement.

Two other emerging trends are also becoming apparent in regard to the effect of airports on the urban form. The first is the tendency for immediately proximate land uses to be industrial or heavy commercial (including motels, conference facilities, etc.) in nature, with land uses adjacent to or near the airport tending toward low cost housing -- both single family and multiple units. This trend is visible at all levels of airports, naturally it is more apparent around major facilities because they draw more activities to them. The second trend that is emerging, though it is often not recognized, is the fact that airports are becoming one of the few remaining major open areas in the urban environment. Furthermore, they are open areas that can be utilized, and are being utilized in some places, as a large recreational faciltiy.

Another emerging trend that is much more limited than the preceding is that of the airport city. This is occurring at major continental and inter-continental

airports in the major metropolitan and megalopolitan areas. San Francisco, New York, Los Angeles, Chicago, Paris, and London are all experiencing this phenomenon.

Hamilton Municipal Airport

Hamilton Airport's history is not unique. Many citizens may not realize that the city has been intermittently involved with the Department of National Defense and with the Department of Transport in the establishment of a municipal airport since 1927. Three sites have been used. The first, at the present location of Stewart Park, the second farther west and inland, near Redhill Creek, and the third, established as a military base under the air commonwealth training programme, is Mount Hope airport. Of these early years of aviation in Hamilton one writer has noted:

> "The history of the old Hamilton Municipal Airport illustrates a number of interesting factors of airport location and responsibility, and from it, perhaps, there is something to be learned which will help in formulating modern municipal airport policy. Hamilton did provide initiative by investing in the original site, but it was apparent from the beginning that there was no real airport policy. The failure of the International Airways venture and the general business collapse of the depression combined to make the airport something of a white elephant almost from the beginning, and to produce civic disenchantment in the whole affair. Generally the airport tract was too large for the limited activities of the depressed 1930s, but too small to be a major WWII training airfield. Had it been selected as a major link in the Trans Canada Airway system of the 1930s its use as an airfield would probably have been perpetuated only partially developed and obviously underused, and hence completely vulnerable to the competition which higher land uses imposed.
>
> The original site selection appears to have been unwise, as was pointed out by DND inspectors after the choice was made. Had Mr. Elliott's waterfront site been chosen instead it is possible that the airport could have remained, and expanded, with increased space

requirements on fill supported runways into the harbour. The heavy industrial belt has intruded close to this original site, but such use is largely compatible with an airport, much more so than the residential developments which intruded the chosen site. In addition a harbour location would have permitted integrated seaplane operation, something which would still be moderately significant. Had this site been selected originally, an airport comparable to Toronto Island might have resulted.

Inadequate zoning may have played a further role in the demise of the old Hamilton airport. Zoning was imposed in the late 1930s, but quickly broke down when wartime and post war pressure for residential space appeared. Even with adequate zoning and enforcement it is probable that the demand for space below the escarpment would have led to the squeezing out of the extensive airport space. Most of Hamilton's expansion back of the mountain has occurred since WW II, and only after most of the contiguous lake front land had been built upon.

The desire to retain the old airport for commercial operation was a logical one as well, although it was apparent that it could not continue on that site indefinitely. Charter, executive, and even flying training activities must be close to their markets, and the old site had the great advantage of proximity.

Even if the old airport had had more to offer on the eve of World War II it is probable that Mt. Hope would still have been built. Few of the wartime training fields were located this close to large cities. A few of the elementary schools were on existing community airports, but even then most of them were somewhat removed from contiguous built-up areas." [2]

This report will not exhaustively review the history of Mount Hope airport because it has been very thoroughly researched by Professor Neil McArthur in his Case Study in Airport Land Use. Professor McArthur reviewed the development of Mount Hope airport as a military airport, its subsequent revision to a general

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[2]N.M. McArthur, A Case Study in Airport Land Use, (mimeo), 1963.

aviation role and, ultimately, its somewhat ambiguous status as Hamilton municiple airport. His study ends in 1963 and it is, therefore, necessary to review the development of Mount Hope airport since that time.

After considerable debate and consideration of various alternative open, it was agreed in 1967 that the City of Hamilton should assume responsibility for the maintenance of the airport and that Department of Transport navigation aids and a D.O.T. Control Tower would be operated.

In March of 1968, the City invited several air carriers to assess the Mount Hope facility with a view to providing some form of commercial air service. Nordair alone responded to this invitation, suggesting that, on the basis of their preliminary studies, it appeared feasible to initiate daily Hamilton-Montreal and Hamilton-Pittsburgh jet service. In its submission, and in subsequent status reports, Nordair stressed that this iniative was largely dependent upon two factors:

(1) Mount Hope was the only area airport able to accommodate jet equipment. Its location made it ideal for eventual designation as a Class 1 regional airport serving not only the City of Hamilton but also numerous highly-industrialized communities in the Niagara Peninsula that are only a short drive from Mount Hope.

(2) Considerable industrial and population growth is forecast for the area served by the Hamilton Municipal Airport. With increasing air and surface traffic congestion at Toronto International Airport,

it appeared a desirable transportation policy to divert as much regional air traffic as practical to another terminal.

On February 24, 1969, approval was granted for the Hamilton-Montreal service. Authority was also granted for the Hamilton-Pittsburgh service, pending approval by U.S. authorities.

Nordair commenced service April 28, 1969, on the Montreal-Hamilton route and passenger volume has been steadily increasing since that date. The company predicts that in the calendar year 1970, 66,000 passengers will fly in and out of Hamilton via Nordair. In the meantime, the City has undertaken improvements to the passenger terminal, the parking lot has been graded and (as of this writing) is partially paved. A new Flight Control Tower went into operation in April 1969, a highly sophisticated instrument landing system came into use in September, 1969, a runway improvement programme was completed in the fall of 1969, and in 1970 the DOT meteorological station was transferred to the airport.

The effect has been to greatly enhance the payload characteristics and the schedule reliability of the large aircraft, as well as to stimulate considerable new aviation business and private aircraft movement at Mount Hope. In 1969, Mount Hope was the 9th busiest airport in Canada (see Exhibit 1).

Ground Transportation

It must be conceded at the outset that the present and proposed ground access to Mount Hope airport is inadequate. Little concern seems to have been shown until very recently for the imminent industrial development of the Nanticoke,

Airports with Department of Transport Towers
Total Aircraft Movements by Class of Operation, August 1970

Aéroports avec tours de contrôle du ministère des Transports
Total des mouvements d'aéronefs, par classe de vol, août 1970

Airports — Aéroports	Total August 1969 août	August 1970 août							
		Total	Rank — Rang	Itinerant — Itinérant	Rank — Rang	Local — Locaux	Rank — Rang	Simulated approaches — Approches simulées	Rank — Rang
Abbotsford	10,894	11,759		5,239		6,332		188	
Baie Comeau	3,197	2,634		1,692		942		—	
Brandon	5,049	3,557		1,394		2,150		13	
Buttonville	18,875	17,542	8	4,507		12,947	3	88	
Calgary International	19,798	20,034	5	7,875	7	11,954	5	205	
Cartierville	10,140	282		280		2		—	
Edmonton Industrial	18,736	18,974	6	8,289	6	10,632	6	53	
Edmonton International	4,467	4,457		2,340		1,564		553	6
Fort St. John	2,603	1,749		1,604		128		17	
Fredericton	6,671	5,421		2,614		2,712		95	
Gander International	7,530	6,407		2,382		3,974		51	
Halifax International	6,211	6,025		2,998		2,999		28	
Hamilton City	16,746	17,139	9	4,091		12,597	4	451	7
Kamloops	6,978	5,523		4,185		1,312		26	
Lethbridge	4,269	4,054		1,617		2,355		82	
London	10,360	10,904		4,397		6,282		225	10
Moncton	8,129	9,281		2,596		6,430		255	9
Montreal International	24,472	23,862	2	14,238	3	8,636	10	988	3
North Bay	5,024	7,003		5,345		1,052		606	4
Oshawa	—	8,787		2,588		6,148		51	
Ottawa International	16,985	18,106	7	7,862	8	9,269	8	975	2
Penticton	5,405	3,161		2,164		994		3	
Pitt Meadows	12,754	15,182		4,942		10,240	7	—	
Port Hardy	1,693	1,817		1,348		467		2	
Prince George	4,443	5,125		2,347		2,778		—	
Quebec	12,357	12,039		6,055	10	5,875		109	
Regina	7,907	9,147		3,753		5,248		146	
Saint John	2,043	1,853		1,490		262		101	
St. Andrews	10,731	11,364		2,140		9,224	9	—	
St. Hubert	32,624	29,665	1	8,491	5	20,975	1	199	
St. John's	1,555	2,350		1,072		1,251		27	
St. Jean	4,062	6,497		2,258		4,210		29	
Saskatoon	7,154	6,162		3,086		3,006		70	
Sault Ste. Marie	—	1,744		1,062		572		110	
Sept-Iles	3,364	2,554		2,092		436		26	
Springbank	—	4,228		1,190		3,038		—	
Sydney	1,235	2,067		1,110		930		27	
Thunder Bay	5,024	4,824		1,889		2,922		13	
Toronto International	19,545	20,190	3	16,177	1	2,910		1,103	1
Toronto Island	21,758	20,100	4	6,874	9	13,226	2	—	
Vancouver International	20,518	16,992	10	14,929	2	1,748		315	8
Victoria International	11,153	9,736		5,847		3,700		189	
Wabush	631	959		761		198		—	
Waterloo-Wellington	6,644	7,631		2,835		4,677		119	
Whitehorse	7,468	8,681		3,412		5,235		34	
Windsor	7,300	8,657		2,745		5,745		167	
Winnipeg International	14,653	15,387		11,426	4	3,378		583	5
August 1970 towers 47 tours		431,612		197,628		225,662		8,322	
Août 1969 tours 44 towers		429,155		191,536		228,645		8,974	
January to August 1970 cumulative		3,093,656		1,321,728		1,691,167		80,761	
Janvier à août 1969 cumulatif		3,028,220		1,262,055		1,679,249		86,916	

Port Dover area to the South. Clearly, however, Texaco, Dofasco, Stelco and Ford, to mention the principal existing or porposed developments, cannot be left indefinitely to rely upon a secondary highway system. The development of Highway No. 6 into a major artery seems to be unavoidable as does the further extension in a southerly direction of Highway No. 403 and its eventual linkage with Highway No. 6. Given this development, Mount Hope airport would be easily accessible from all directions. For the interim, an additional exit from the Highway 403 - Mohawk Road interchange could provide rapid access to Mount Hope airport via improved Township roads.

Rail transportation to the airport is not now provided but could be arranged with little difficulty by running a spur line in from Caledonia, a distance of seven miles.

The Problem

In outlining the factors which led it to initiate a commercial air service at Mount Hope, Nordair touched on the key problem in air transportation which faces this region today. Toronto International Airport is rapidly approaching capacity utilization. Continued development in its present Malton location is limited. The Department of Transport has thus been faced with the task of providing a new Toronto International Airport (the so-called TIA II) or, alternatively, providing supplementary regional airports which would relieve Toronto International of much of the domestic traffic which is now its responsibilty.

It is to this latter alternative that this report is addressed. It may be valuable, however, to briefly review the alternatives open to the Department of Transport:

(1) Several sites for the location of a new airport could be considered and, if one of them met the requirements of the D.O.T. Task Force established to study the problem and make recommendations to the minister, then a new airport on the scale of the Ste. Scholastique, P.Q. development might be anticipated. Apparently, this alternative has not been ruled out as of this writing.

(2) The second alternative is that of developing one or more regional airports (full-service domestic airports). For this alternative to be acceptable,

(a) the regional airport(s) must be able to demonstrate that they would service an area capable of justifying location or improvement on economic grounds;

(b) there must be provision for adequate rapid ground transit from the airport to regional urban centres and between the airport and Toronto;

(c) development of regional airport(s) must leave Toronto International Airport capable of serving the international air traffic needs of South-Western Ontario until well past our present land-use planning period.

Based upon the distribution of the air passenger market potential, it has been found that Hamilton Airport is reasonably well-located to serve the air passenger market potential of the Study Area. It is as well-located relative to

the market as most other major airports for which market potential distribution data are available. This report demonstrates the feasibility of the second option with respect to Mount Hope airport.

Cognizant, however, of the objections which have been raised by citizen's groups, we also believe it is necessary to consider very seriously the questions and the doubts raised by these groups through an examination of the impact of airports on surrounding and adjacent land uses. Five categories are utilized to facilitate the isolation of the various factors that affect airport environs. In reality, they cannot be separated or isolated -- as will become evident.

A. Noise

Jet engine noise is what is termed "broad band noise" in that it covers the whole audio frequency range from say 40 to 10,000 cycles/sec. It is particularly noticeable in the very critical audible range from 1000 to 6000 cps. and all jet engines have a large percentage of their total noise output in this very sensitive frequency band. The magnitude of the noise level at any particular frequency can be expressed in power units for example, watts. However in actual measurement it has been found that sound power levels may vary from as little as 1×10^{-5} watts, for voice at normal conversational levels, to a 1×10^{5} watts, for a small turbojet engine, and this very wide range of power is difficult to measure utilising a single linear scale instrument. To facilitate matters, a logarithmic scale to the base 10 has been developed which compresses the linear scale. Of considerable importance to us is the fact that the human ear also

measures sound on roughly a logarithmic scale and so if the sound level meter records an increase of 3 decibels, which means that the sound level is doubled, the human ear indicates roughly the correct response. The sound level meter, therefore, displays the sound pressure level in decibels generally in one of eight octave bands from 37.5 to 9600 cps., although the complete spectrum can also be traversed to obtain the sound pressure level at any particular frequency. The sound level meter can also record or display the overall sound pressure level, which is an integrated value over all octave bands.

It is a fact that the human ear does not subjectively measure sound the same at all frequencies. To provide for this change in sensitivity, a subjective rating method has been developed and refined during the past few years. The units for this rating scale are called "Perceived Noise levels" abbreviated as PNdb. The term "Perceived Noise level" is generally applied to an octave band analysis and corresponds to the overall sound pressure level when an adjustment has been made to account for frequency distribution and the response of the human ear.

With respect to a sound pattern around an airport it is, therefore, entirely possible, given the type of aircraft in operation, to complete a set of perceived noise level contours for specified take off and landing patterns. Perceived noise levels can thus be determined for any given location as a result of known sound sources.

The above noise contours form the basis for a step-by-step procedure whereby the community response to aircraft noise can be estimated. For example, knowing

the frequency of operations, the periods of operation (night or day), etc., as shown in Table 1 of the appendix, a series of corrections can be applied to subjectively correct the perceived sound pressure levels contours. These corrected contours are called the Composite Noise Rating contours abbreviated (CNR) and once again this rating can be established for a given location. It is emphasized that the CNR contour is a calculated quantity, it cannot be measured with a sound level meter or any other indicating device. However, experience has shown that it is a reliable index for noise levels. Furthermore, tests have shown, that the Composite Noise Rating has certain limits as far as the general public are concerned.

For example, research[5] has shown the following conditions to be generally true: that where the CNR for takeoff and landings was less than 100, and less than 80 for engine runups, there were basically no complaints in residential neighbourhoods. A CNR rating of above 100 in residential areas will induce individual complaint with possible concerted group action.

Accordingly, the perceived noise level contours available in Reference 4, have been modified by the correction as shown in the appendix and the 100 CNR contour only has been shown for each runway of the proposed Mount Hope airport bearing in mind the type of aircraft, frequency and period of operation.

Because the proposed Mount Hope airport is an airport of the future, comments should be made regarding the possible noise level of the new generation of turbojet aircraft.

Let us consider the new Boeing 747. This is not to say that this aircraft will be using the Mount Hope airport but it is an example of current design. The Boeing 747 despite its vast weight is reputed to be noticeably quieter than the familiar Boeing 707, or the Douglas DC8. The turbojet engines powering the 747 are at least 5 decibels quieter than the by-pass engines powering the DC8's for example. Newer engines of the fan type as exemplified by the Rolls Royce RB211 designed for the Lockhead Tristar are even quieter since the engine design permits considerable acoustic treatment directly within the engine itself. The overall trend of jet engine noise is downward with about a 10 decibel reduction achieved in the decade from 1960-70. While this significant decrease per decade cannot go on indefinitely: engineering achievement will undoubtedly reduce the sound level by 1975 an additional 3 decibels which, as we pointed out earlier, is a reduction of the overall sound level by 50%.

A second observation concerns the sound contour levels which are shown for take off. These are a function of the take off patterns which are constantly being modified to permit higher rates of climb off the end of the runway. This means that with the newer generation aircraft the 100 CNR contour as shown will undoubtedly shrink to show significant reductions in the noise level in the vicinity of the airport.

B. Safety

Safety is basically concerned with the aircraft airborne operations, i.e., landing, take off, and flight. Ground operations constitute little or no safety

problems for the lands surrounding an airport. When the flight paths to and from an airport pass over inhabited areas, operations can constitute a potential hazard to people who live and work in the airport approach zones. The possibility of an aircraft crashing is greatest in the narrow elongated strip of land that underlies the approach zones to runways on airports. Commercial (air carrier) and military airplane accidents that have caused death or injury to persons on the ground near the airports have, in most cases, occurred within the approach zone and close to a projection of the centerline of the runway. In this respect, the proposed flight paths for re-oriented runways of Mount Hope do not constitute a major hazard to the community and, it is conceivable that those houses which lie within the approach zone could be physically removed if their owners so wished. See Appendix.

This would not only provide a desirable situation for safety, but it would also eliminate some of the potentially noisiest areas from more intensive uses. Generally, from the point of profitability, open area recreational uses, such as golf courses, are found to be best suited for those areas. Again, Mount Hope airport's situation is in line with this conclusion.

C. Air Pollution

Pollution from jet aircraft is a problem of considerable interest and concern wherever a major airport exists. It is true that turbojet aircraft contribute only a small fraction of the pollutants clogging our atmosphere as recent evidence

shows.[3] However, as aircraft activity increases at Mount Hope airport the aircraft's share of air pollution in this specific area is bound to rise.

A review of the literature shows that only within the last year or two have studies been made[4,5,6,7,8] to obtain reasonably complete information on the kinds and quantities of air contaminants emitted by jet engines. Below, briefly, is a summary of the facts concerning the three primary types of jet engine pollutants.

(1) Some members of the present family of gas turbines emit particulate matter (small size carbon particles). These are visible "smoke" emissions and, with their soiling effect, are offensive

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[3]"Jet Aircraft: A Growing Pollution Source", R.E. George, J.A. Verssen, R.L. Chass, Journal of the Air Pollution Control Association, Vol. 19, No. 11, November 1969.

[4]"Reducing Jet Pollution Before it Becomes Serious", R.F. Sawyer, Astronautics and Aeronautics, Vol. 18, No. 4, April 1970.

[5]"Air Pollution Characteristics of Gas Turbine Engines", R.F. Sawyer, D.P. Teixeira, E.S. Starkman, TRANS ASME, Journal of Engineering for Power, October 1969.

[6]"Oxides of Nitrogen From Gas Turbines", D.S. Smith, R.F. Sawyer, E.S. Starkman, Journal of the Air Pollution Control Association, Vol. 18, No. 1, January 1968.

[7]"Air Pollution Emissions From Jet Engines", E.R. Lozano, W.W. Melvin and S. Hochheiser, Journal of the Air Pollution Control Association, Vol. 18, No. 6, June 1968.

[8]"Air Pollution By Gas Turbines - Is Control Possible?", J. Odgers, Canadian Aeronautics & Space Journal, Vol. 16, No. 8, October 1970.

to the public. Diesel trucks unless they are very finely tuned offer the same type of particle pollution. Recent modifications to the combustion system of these offending engines show that it is possible to reduce this type of emission to a low level and it is estimated that burner modifications will clean up about 70 per cent of the smoke pollution from jet aircraft. All new aircraft will undoubtedly have these modified combustion systems. It might be added that evidence shows that while smoke looks bad it may not be as harmful to human health as other types of emissions.

(2) Another major source of pollutants arising from high temperature combustion systems concerns the oxides of nitrogen (NO and NO_2). In addition to being toxic, one of these oxides (NO_2) plays a critical role in the formation of photochemical smog. Recent work[9] concludes that the level of NO (the primary oxide) is fixed by the kinetic processes occurring in the combustion chamber and that until there is a break-through in the chemistry of combustion processes the level of nitrogen oxides in any new engine design will not appreciably change.

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[9] Op. cit., "Oxides of Nitrogen From Gas Turbines".

(3) Another pollutant, oxides of sulphur (generally SO_2), comes from the oxidation of the sulphur contained in the fuel. Fortunately, the percentage of this oxide is very low in any aircraft exhaust system because of the purity of the fuel used in the turbojet aircraft. This purity is maintained because of corrosion possibilities.

Other pollutants which are considered to be of secondary importance, possibly because of the limited information available regarding their production and effect, may be listed as carbon monoxide, unburnt hydrocarbons, aldehyde and aerosol emissions and characteristic gas turbine exhaust odours.

In summary, the current contribution of gas turbine engines, which are primarily used for aircraft, to the total air pollution is small. Much more work is necessary to fully evaluate the amount of pollution and its overall effect near any airport. In view of the low percentage utilization of the proposed extensions to Mount Hope airport air pollution effects are not believed to be an important factor. It is recommended, however, that pollution measuring devices be installed at key positions in the airport vicinity to monitor the major pollutants so that if necessary the utilization of the airport can be carefully controlled.

D. Effect on Land Values

The effect of airports on land values was generally treated in our preliminary brief. It appears that if surrounding lands are mainly residential,

then airports are likely to cause a decline in property valuation until the population -- industrial mix of the community adjusts to maximize the benefits of the airport. In the case of Mount Hope airport, of course, the surrounding lands are presently agricultural or undeveloped save for the community of Mount Hope itself. The economic impact of the proposed Mount Hope developments would, therefore, almost certainly be positive.

The Impact of Surrounding and Adjacent Land Uses on Airports

The surrounding and adjacent land generally affects airports in three manners; limitation of expansion by encroachment, limitation of air operations by community reaction to aircraft noise, and limitation of air operations through aviation hazards. The problem of noise as an effect of airport operations was discussed previously, the result of aircraft noise disturbances of sufficient magnitude to create adverse community response will usually be a curtailment of aircraft operations over a certain part of the community. This may take the form, generally, of restriction to preferential runways and flight paths. This requires the aircraft to land and take off from runways that are best oriented for noise abatement or to fly an approach or departure pattern that moves aircraft noise away from the residential areas. A second and more severe restriction is that of curtailment of aircraft activity at certain hours or days from the airport. This latter is not found too often at commercial or municipal airports -- and should not be a problem for the proposed Mount Hope expansion.

Encroachment is the problem that results from development of property around airports and the ends of runways. This severely limits the expansibility of the airport and it creates a noise and hazard problem. This latter problem is the limitation of aircraft activity due to hazardous conditions existing from structures or natural features in the airport area. In this case, such things as tall buildings and structures or trees in the approach and departure zones will cause a hazardous condition to exist as far as air navigation is concerned and will result in restricting the type of aircraft that can utilize a particular facility, or it will cause an unnecessarily high holding pattern and may require undesirable avoidance procedures during take off or landing.

To avoid these situations, two types of legal instruments have been utilized. One is the use of airport zoning to restrict the types of land uses which may develop around the airport. The second is the use of aviation and hazard easements. The latter are designed to protect the airport against hazards to aircraft operation and to grant a right of flight over the subject property with the right to cause noise in the airspace above the subject property. Both should be considered for prompt initiation in the Mount Hope situation.

A third alternative, which is used by some airports, is the purchase or acquiring first options on land surrounding the airport that may be necessary for future expansion or clear zones. This alternative has a basic disadvantage in that it requires substantial outlays of capital or reserves to purchase or hold options and be prepared to exercise the option at any time.

Some airports lease this land to commercial and industrial uses or to agricultural uses which are compatible with aircraft operations and noise. In either case, a substantial investment in purchase and development costs is required, and this may mitigate against such action.

Some examples of how this type of development is handled are as follows: outdoor areas such as parks, golf courses, playgrounds, riding and hiking trails, botanical gardens, and swimming facilities are all compatible with airport operations. Golf courses are becoming popular, and parks take comparatively little development and are ideal for riding and hiking trails with outdoor living facilities. Reservoirs and ponds fit into park areas and golf courses. Swimming pools, tennis courts, playgrounds and athletic fields may be grouped together with a club-house restaurant facility. Botanical gardens can be fitted in with most of the above activities. Any and all of these uses add interest, beauty, and activity to the airport area.[10]

Fresno, California has developed a plan for the city and county in which about 1,000 acres of property near the airport is to be developed into park area. This serves several purposes, one being the provision of a large outdoor recreational area reasonably close to the city, a third consideration was that by combining such outdoor activities in one area it was possible to relieve recreation buildings or convention centers within the city and devote them to cultural pursuits such as

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[10]NANAC, December 1, 1964.

art, drama, music, and so forth. All of these are valid reasons for provision of this facility and in this case justified the cost of development in the view of the Fresno County and City Planning Commission.[11]

The Seattle-Tacoma (Washington) International Airport has proposed a golf course for the south end of the airport with the land to be leased for a twenty-five year period on the following terms:

"Area: Approximately 97.72 acres.

"Term: 25 years: Effective with exercise of option and in five year segments for the purposes of rental re-evaluation.

"Rental: For the first five-year period percentage of gross receipts as follows: 20% of the first $50,000 gross receipts from gross fees and driving range operation; 10% of next $50,000 to $100,000; 5% of all over $100,000; 5% of all revenues derived from operation of a golf pro shop; 20% of all revenues derived from operation a restaurant concession within the facility. Lessee further agrees to pay the following minimum annual guaranteed rent:

1st year:	$ 6,000,	payable monthly at $500.00
2nd year:	7,200,	payable monthly at $600.00
3rd year:	8,400,	payable monthly at $700.00
4th year:	9,600,	payable monthly at $800.00
5th year:	10,800,	payable monthly at $900.00

The sponsors of the golf course are expected to "spend up to $150,000 for the construction of the course, a club house, pro shop, and small restaurant."[12]

At the Long Beach, California Municipal Airport, industrial, commercial, and recreational land uses are utilized around the facility. Additionally, the

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[11]Fresno Planning and Inspection Department, Parks-Recreation and Sports Center Plan, Fresno City Planning Commission, General Plan for the Fresno-Cloris Metropolitan Area, 1958 and 1954.

[12]NANAC, July 15, 1964.

San Diego Freeway runs immediately south of the airport. The industrial uses are located on the south and west side of the airport, on the north and east are golf courses with Douglas Aircraft Company also on the north. In Richmond, Virginia, at the Richard E. Byrd Flying Field, land has been rented on a year-to-year basis for farming purposes. The lease is subjected to cancellation by notice of either party, thereby leaving the farmer unprotected for the investment in fertilizer and other soil building properties. This disadvantage is offset by a low annual rental rate of one dollar per acre. In this case the airport benefits in that it saves the cost of maintenance of the property and it is kept under cultivation all year. The principle crop in this case happens to be soy bean and has been profitable for the farmers. In Oklahoma City the land in the vicinity of Will Rogers Field is leased to wheat farmers and cattle grazers.

The above examples are some of the ways American airports are handling the problem of sufficient land for expansion, protection for noise and for safety considerations. These solutions may not all be applicable in Canadian communities, nor are they commonplace in Canada. They ought, however, to be seriously reviewed and considered if Mount Hope airport is developed.

E. Development Costs

Cost can only be estimated very crudely at this juncture and it is, therefore, better to consider the cost factor in comparative or relative terms using known estimates for airport projects now in process.

The original estimates for the new Montreal International Airport located at St. Scholastique were in excess of $420,000,000. Development of a similar, new facility for Toronto (TIA II) could reasonably be expected to cost as much or more. By contrast, the estimates for the proposed expansion of Calgary airport so as to provide it with two, 10,000 foot runways, a new terminal, and modified ground access routes is about $200,000,000. The latter proposal bears an obvious similarity to the proposal which has been put forward for the development of Mount Hope Airport. Recent newspaper reports have attached a value of $135,000,000 to the Mount Hope expansion and $500,000,000 to the development of a new site as TIA II, attributing these figures to the Department of Transport.

We have been able to find no evidence to substantiate these estimates nor will the Department of Transport confirm the figures. They do not, however, appear to be unreasonable in relative terms. The question then, which must be addressed is this: what additional benefits will accrue from the commitment of 300 to 350 million additional dollars if the decision is in favour of TIA II? Concommitantly, what will be the negative aspects of such a decision?

It is not the purpose of this brief to present a cost-effectiveness evaluation of the two proposals. It is worthwhile, however, to review some of the principal considerations which might be subsumed in such a study. Of these, the most important, in the short term, is cost. Neither the citizens of Hamilton, nor the

citizens of Toronto will pay directly for their airport. It is a federal undertaking financed from the federal treasury and, as such, every taxpayer in Canada has a stake in the new airport. Because of the considerable disparity in their respective, probable costs, the choice of a TIA II development must demonstrably have a greater long term benefit because of its effect on such factors as regional development and the reorientation of existing patterns of inter-industry linkages. Provisions of a new airport simply to meet the needs of Toronto's burgeoning population will not, of itself, provide a sufficient rationale.

Conversely, if it is decided to develop Mount Hope Airport as a regional facility, then, again, the benefits must justify the cost. Included in this evaluation will be consideration of population, industrial, and commercial growth trends. This has already been touched upon in our earlier report and the population trend is further considered in the section of this report dealing with projected air transport traffic. It is worth noting, however, that in the interim, the time span during which development of the Lake Erie front might be anticipated has been lengthened by two or more years. Both of the major steel companies which were contemplating the construction of new mills have now deferred their plans. They have not, however, abandoned their plans. Meanwhile, in the absence of incentives for light industry to relocate on top of the escarpment, the growth of population in Hamilton's Wards 6, 7, and 8 and in

Wentworth County is beginning to incite housing developments and the planning and construction of complementary retail and commercial facilities in the Mount Hope vicinity.

If the shift from Burlington Street to the mountain top does not proceed in a planned fashion, so as to include provision for industrial parks or "nodes" and so as to retain the existing recreational areas as open space then it is entirely likely that the contemplated expansion of Mount Hope Airport will be dysfunctional.

The existence of improved facilities at Buffalo airport and the development of a high speed highway link has rendered this airport a viable alternative to Toronto International Airport for those persons in St. Catherines, Niagara Falls, and adjacent communities who are travelling to points in the United States. As our projected potential passenger estimates indicate in a subsequent section of this report, Hamilton and the area to its South and South West already generate sufficient domestic demand to justify an expanded facility at Mount Hope. The Canada-U.S.A. traffic which is accommodated by Buffalo airport, though unmeasured, may in many instances, be better directed through a regional airport at Hamilton.

AIR TRANSPORT TRAFFIC AND ITS ECONOMIC IMPLICATIONS

This section is divided into two parts. The first part presents air traffic forecasts for the Hamilton Metropolitan area for the years 1968 through 1985. These forecasts are limited to commercial, air passenger traffic and aircraft movements. In the latter case, only current data are presented. The second part presents forecasts of the employment related to airport activities. These employment figures are translated into economic terms.

Air Traffic Forecasts

Before presenting the traffic data a brief review of the procedures and limitations of this sub-section is in order. First, air freight, air cargo and air mail have not been considered for two reasons. The first is time and data constraints. The second is the attitude which, rightly or wrongly, characterizes the approach to air freight which is taken by carriers. Their primary market is in passenger service. If passenger demand is sufficient to warrant a scheduled run then the carriers are interested in providing that service. If, in addition, there is a possibility of some air freight movement in conjunction with and only in conjunction with the regularly scheduled run, then this too is of interest. This has given rise to a pricing schedule which rather than being profit oriented *per se* is based on contribution to unallocated overhead. As a marketing policy this clearly mitigates against the development of scheduled air freight runs. Further, such a marketing policy is unlikely to change so long as the aircraft

in service have large cargo sections which are not fully utilized. Air Canada has been experimenting with combined Air Freight-Passenger Service on a scheduled Trans Atlantic Flight but no data are, as yet, available on the success of this venture. The absence of forecasts for these items in this report, should not be taken to mean that in the future they will not be important.

Information regarding air charter activities is also tenuous but of considerably more importance. Two observations are in order. First, most charter activity will be international, and for Mount Hope to originate or receive such flights it is necessary that it be designated as an international airport. It is now designated as a "Port of Entry" and the change in classification should create few problems. Second, even if Mount Hope were expanded and given an international designation it is probable that those carriers which have their major servicing facilities at Toronto International Airport (notably Air Canada and BOAC) would continue to operate their charter flights from that base.

Apart from these caveats, however, it could reasonably be expected that all other charter service now originating or terminating in Toronto would be directed to Mount Hope. An analogy can be drawn here to the Heathrow-Gatwick airports (London, England) in their division of traffic.

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As far as can be ascertained, during the period February-July 1969, Hamilton and the region to its South and South West originated 25 charter flights -- all international which carried a total of 4, 953 passengers.[13] During

[13]Canada Transport Commission, Trans Atlantic Flights Approved by the Air Transport Committee.

the same period a total of 341 charter flights originated in Toronto, of which Air Canada, BOAC and BEA were designated at the carrier for only 26.[14] Certainly, not all of the remainder but a very large proportion of them could be reasonably expected to originate at Hamilton International Airport if the proposal to expand that facility is approved.

With respect to the commercial passenger traffic, it was originally intended that a simple mathematical forecasting model be developed. This proved infeasible. The primary constraint effort, parameter specification, proved an intractable problem. It does appear, however, that such a model is possible if appropriate data and adequate time are available.

The procedure finally adopted consists of "best estimates" based on the simplifying assumption that the future Hamilton Metropolitan area air travel demand relationships will remain similar to the existing situation. Certain assumptions are required for making the estimates. In brief the assumptions are:

(1) The Hamilton air passenger area accounts for approximately 17% of Toronto International Airport traffic.[15]

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[14] Ibid.

[15] This estimate is based on: Nordair Ltd., Survey of Origin of Hamilton Boarding Passengers, Montreal: Nordair Ltd., July 1970; Eastern Airlines, Docket No. 20932, Exhibit EA-R-6; M.G. McLeod, "A Comprehensive Survey of Passengers flying from Toronto International Airport, May-June 1968", UTIAS Technical Note No. 141, Institute for Aerospace Studies, University of Toronto, August 1969; De Leuw, Cather & Co. of Canada Ltd., Toronto International Airport Ground Transportation Travel Surveys August 1969. Toronto: De Leuw, Cather & Co. of Canada Ltd., February 1970.

(2) The city-pair air traffic relationships are the same for both the Hamilton and Toronto areas.[16]

(3) Three possible growth rates may be used to represent low, medium and high annual increases of air passenger traffic. These are 5%, 10% and 15% per annum, respectively.

(4) Assignment of routes between the paired cities is assumed. It is worth observing, however, that the ability to grant franchises to various carriers has other ramifications. Not all provide for connections or through service. A recent survey of non-users of Nordair's existing scheduled flight places this lacuna high on the list of reasons for flying from Malton airport. By the same token, through its assignment of routes and division of franchises the Federal Department of Transport can virtually guarantee whatever minimum use rate is considered economical.

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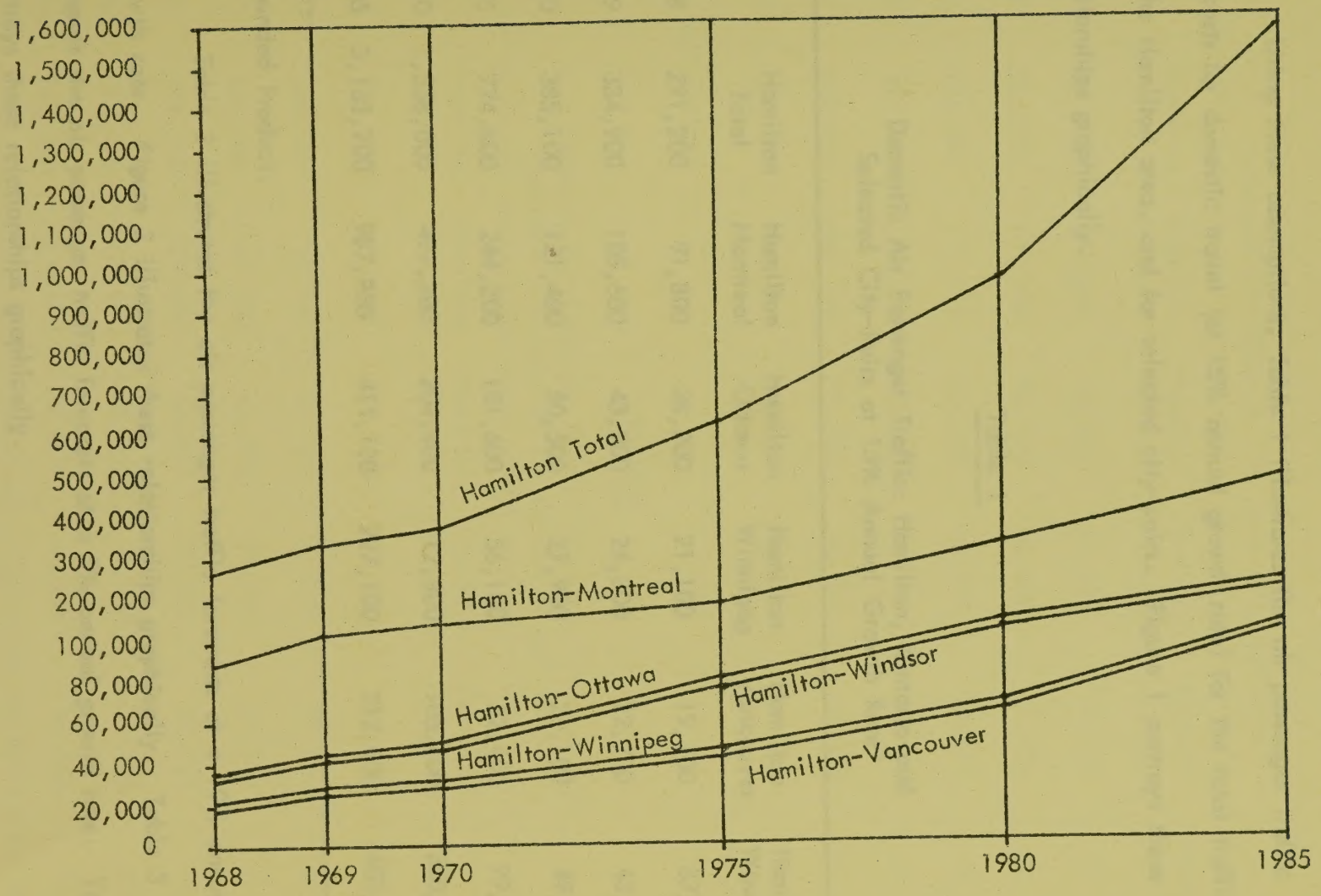
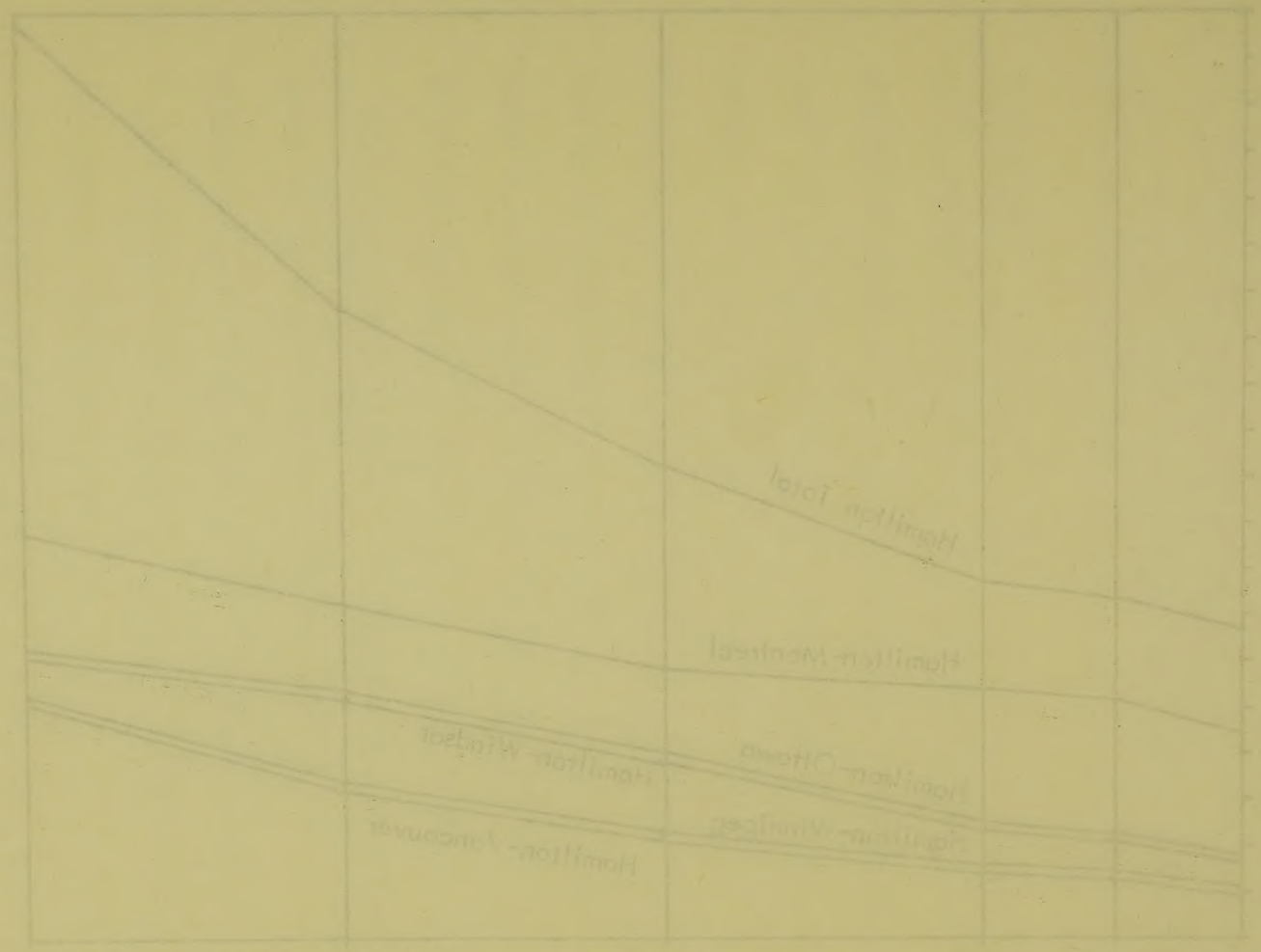
[16]City-pair travel patterns derived from DBS, Airline Passenger Origin and Destination Statistics Domestic Report 1968, Catalogue No. 51-204, Ottawa: The Queen's Printer, July 1970. Partial evidence supporting this assumption deduced from Nordair, op. cit.; "Scheduled Service Activity Projections for the Hamilton Civic Airport", Montreal: Nordair Ltd., February 1970 and "Exhibits II, III, IV, Nordair Ltd., 1970; and McLeod, op. cit.



Airline Passengers at 15% Annual Growth Rate

FIGURE 1



Using these assumptions, Table 1 illustrates the air passenger traffic forecasts for domestic travel (at 15% annual growth rate) for the total traffic in the Hamilton area, and for selected city-pairs. Figure 1 portrays these relationships graphically.

Table 1

Domestic Air Passenger Traffic: Hamilton, Ontario and Selected City-Pairs at 15% Annual Growth Rate*

	Hamilton Total	Hamilton Montreal	Hamilton Ottawa	Hamilton Winnipeg	Hamilton Vancouver	Hamilton Windsor
1968	291,200	91,800	38,200	21,100	19,700	37,500
1969	334,900	105,600	43,900	24,300	22,700	43,100
1970	385,100	121,400	50,500	27,900	26,100	49,600
1975	774,600	244,200	101,600	56,100	52,400	99,800
1980	1,558,000	491,200	204,400	112,800	105,400	200,600
1985	3,133,700	987,900	411,100	227,100	212,000	403,500

*Rounded Product.

Table 2 illustrates the air passenger traffic forecasts at a 10% annual growth rate. Figure 2 illustrates these relationships graphically. Table 3 presents the air passenger traffic forecasts at a 5% annual growth rate. Table 3 portrays these relationships graphically.

Table 2

Domestic Air Passenger Traffic: Hamilton, Ontario and Selected City-Pairs at 10% Annual Growth Rate*

	Hamilton Total	Hamilton Montreal	Hamilton Ottawa	Hamilton Winnipeg	Hamilton Vancouver	Hamilton Windsor
1968	291,200	91,800	38,200	21,100	19,700	37,500
1969	320,300	101,000	42,000	23,200	21,700	41,300
1970	352,400	111,100	46,200	25,500	23,800	45,400
1975	567,500	178,900	74,400	41,100	38,400	73,100
1980	913,900	288,100	119,900	66,200	61,800	117,700
1985	1,471,900	464,000	193,100	106,600	99,600	189,500

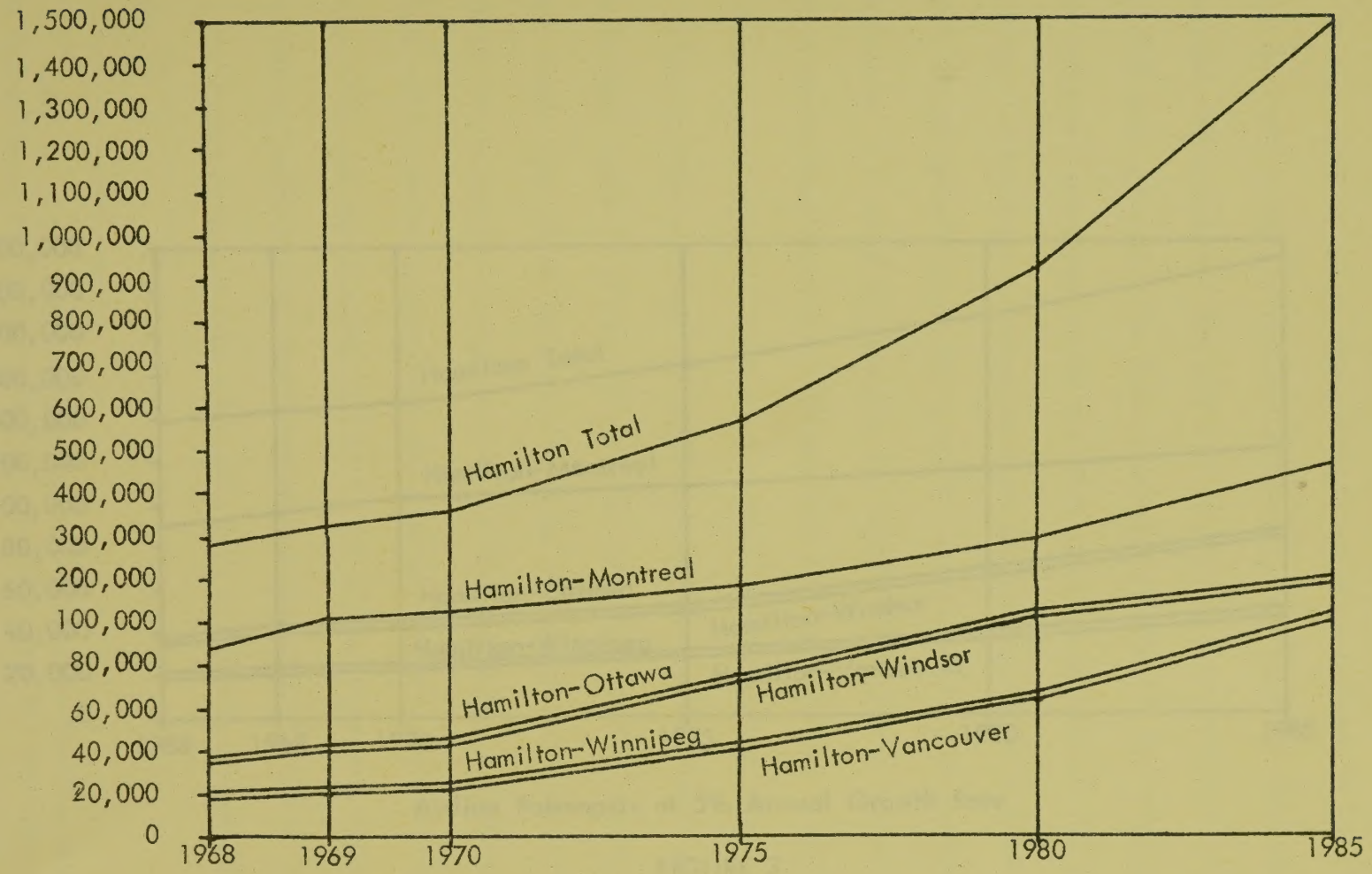
*Rounded Product.

Table 3

Domestic Air Passenger Traffic: Hamilton, Ontario and Selected City-Pairs at 5% Annual Growth Rate*

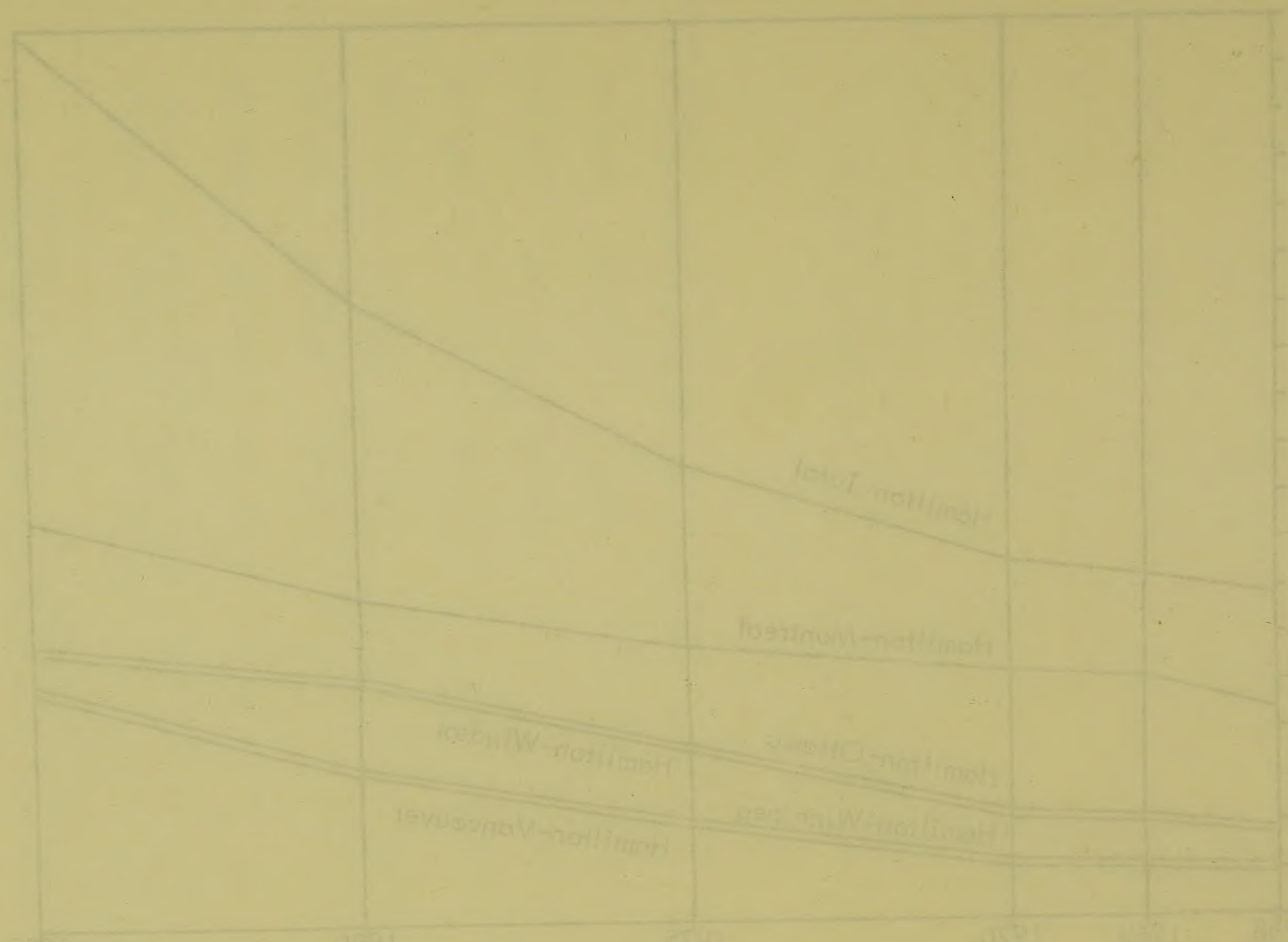
	Hamilton Total	Hamilton Montreal	Hamilton Ottawa	Hamilton Winnipeg	Hamilton Vancouver	Hamilton Windsor
1968	291,200	91,800	38,200	21,100	19,700	37,500
1969	305,800	96,400	40,100	22,200	20,700	39,400
1970	321,000	101,200	42,100	23,300	21,700	41,300
1975	409,700	129,200	53,800	29,700	27,700	52,800
1980	523,000	164,900	68,601	37,900	35,400	67,300
1985	667,400	210,400	87,600	48,400	45,200	86,000

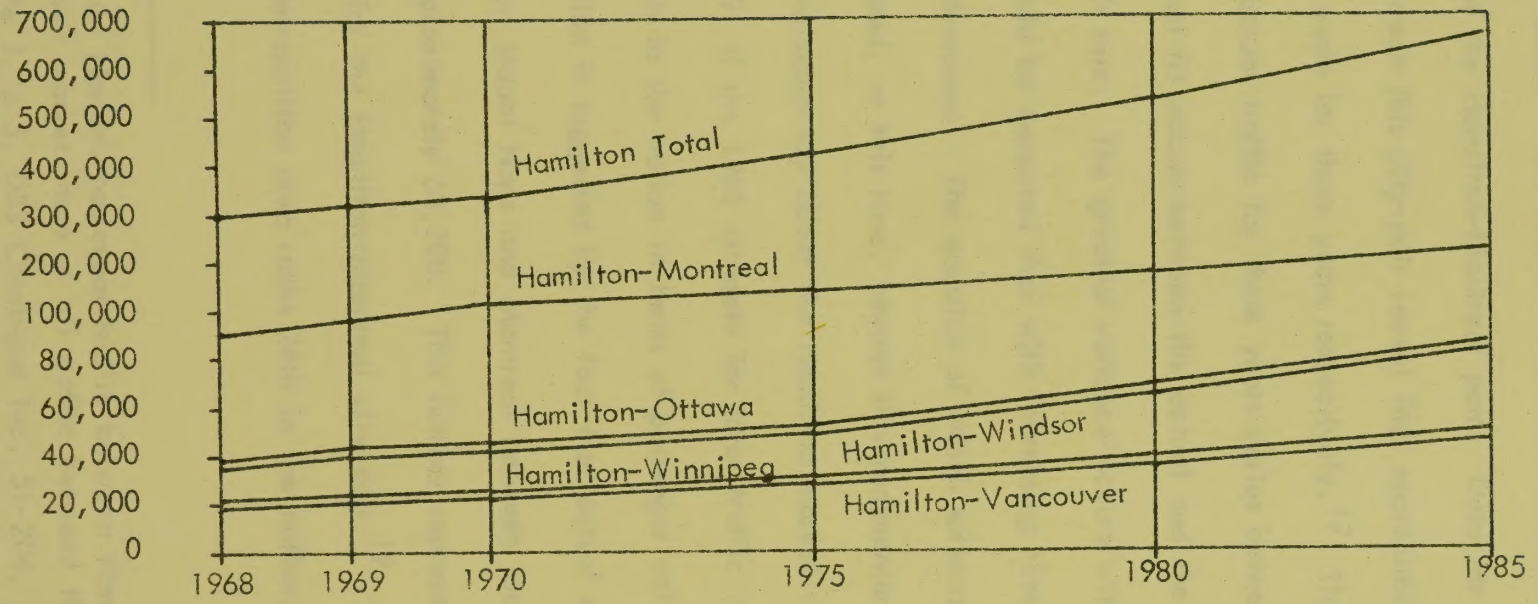
*Rounded Product.



Airline Passengers at 10% Annual Growth Rate

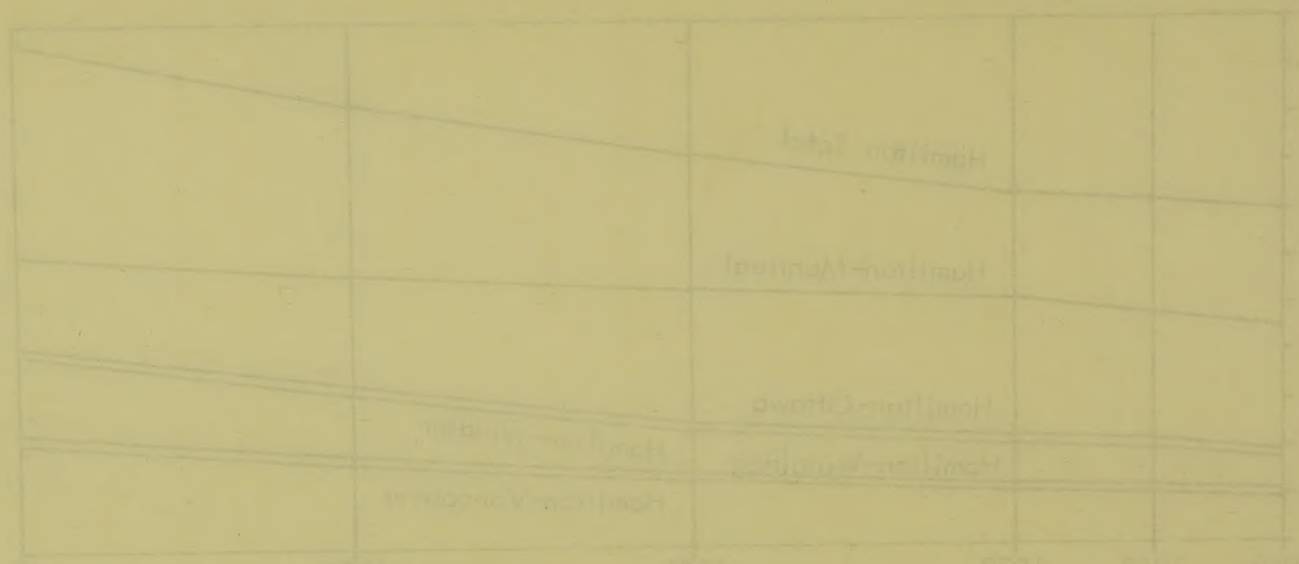
FIGURE 2


Hamilton-Toronto
Hamilton-Montreal
Hamilton-Ottawa
Hamilton-Winnipeg
Hamilton-Vancouver



Airline Passengers at 5% Annual Growth Rate

FIGURE 3



It might well be asked: "How reliable are these forecasts?" The only estimator available is for the Hamilton-Montreal pair. Data for 1969 and 1970 air passenger traffic between this city-pair reveal that approximately 101,000 and 122,000 trips were made for these years respectively.[17] The difference between estimated and actual traffic for these years varies between the assumed growth rates. The closest fit occurs between the actual and the estimate based on a 15% annual growth rate. The greatest variance occurs with the low growth rate assumption. It would be expected that with increasing time the validity of any set of assumptions decreases. The question of which estimate is most appropriate cannot be evaluated, at this time, beyond this rudimentary level.

What do these estimates say about the Hamilton market vis-a-vis the rest of the domestic market? If the 1968 estimate for total traffic is correct, then Hamilton would rank 7th in the nation in terms of passenger volumes in 1968.[18] Support for this evaluation is suggested by the fact that actual commercial air passenger traffic between Mount Hope and Montreal between October 1969 and September 1970 was approximately 63,300. This number represents approximately 50% of the air traffic for the Hamilton-Montreal city-pair.[19] Just on this traffic alone, the Hamilton Metropolitan area ranks 24th in the nation, based on 1968 statistics.[20]

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[17]Based on actual Nordair passenger traffic between Hamilton-Montreal and an estimation of their market share of all traffic between the city-pair.

[18]Based on Table 2, p.5, DBS Catalogue No. 51-204, op. cit.

[19]Nordair revenue passengers and estimate of market penetration.

[20]DBS, op. cit.

Using similar arguments with respect to city-pair rankings, the 1968 estimated traffic places the Hamilton-Montreal pair in 8th position, while the actual 1969-70 traffic places this pair in 14th position according to 1968 statistics.[21]

One final point on air passenger traffic. 1980 population estimates for the Mount Hope market area indicate that approximately 1,400,000 people will reside in this area. Given such a population base, the 1980 air passenger traffic forecasts seem reasonable. The high forecasts suggest an increase in ridership level from approximately .35 domestic trips/person/year to a level of 2.24 domestic trips/person/year.[22] Such a change in ridership level appears greater than the increasing levels of leisure, income, education, and occupation suggested for the South Western Ontario region.[23] The medium forecasts imply an increase in ridership of 1.05 domestic trips/person/year. This change may be consistent with current trends and forecasts. The low forecasts suggest a slight increase in ridership, .48 domestic trips/person/year. This may be less than current trends and the forecast character of South Western Ontario.

With respect to total aircraft movements, Mount Hope ranks 9th in the nation in August 1970. It ranks 4th in the nation with respect to local operations,

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[21] Ibid., Table 3, p. 9.

[22] Market area population forecasts drawn from Nordair, Survey of Origin of Hamilton Boarding Passengers, op. cit.

[23] Ontario Departments of Treasury and Economics and Municipal Affairs, A Strategy for South-Western Ontario Development, March 17, 1970; Government of Ontario, Design for Development: The Toronto-Centred Region. Toronto: Queen's Printer, May 5, 1970; Hamilton Planning Board, Design for Development: South Ontario Region, file No. 802-3284.

and 7th with respect to simulated approaches. The high rank with respect to total and local operations reflects the role which the airport is now performing, i.e., it is a major general aviation facility. If Hamilton airport becomes a fully operated D.O.T. commercial passenger facility, it can be expected that the rank for aircraft movements will be within the top four. Calgary is currently ranked fourth in the nation.

What does the material presented above suggest? First, the Hamilton Metropolitan area can support a full service D.O.T. facility at this time. Second, such a facility should provide substantial relief for Toronto International Airport. Third, the Hamilton Metropolitan area will easily support such a facility in the future. Fourth, since transportation investments tend to generate increased economic and travel activity, it is likely that the provision of a full service D.O.T. facility will increase the economic development and travel demands over and above the forecast levels.

Employment and Economic Impact Related to Airport Activities

The purpose of this section is to translate the air passenger forecasts into employment and economic terms. The most appropriate way to accomplish such a task is through studying inter-industry linkages, i.e., an input-output study. This is not feasible in the context of this report. Furthermore, such a study is not available at this time. Consequently, this study draws on evidence available for other metropolitan area inter-industry linkages.

In Dallas/Fort Worth, Texas, a detailed investigation of the relationships between airports and economic growth indicates that for every enplaned passenger, approximately .002490 jobs are created. This is both direct and indirect employment related to airport activities. Furthermore, such jobs create an annual economic return of approximately $60,000/job. Again, this is both direct and indirect, and includes a regional multiplier effect of 2.3 after eight rounds of transactions.[24]

If it is assumed that similar relationships prevail in the Hamilton metropolitan area, then, granting these relationships and the air passenger traffic forecasts, Table 4 illustrates the number of jobs that would be created if Mount Hope were a full-service D.O.T. facility and air passenger traffic increases 15% per annum. The table indicates that by 1985, 3,900 new jobs would be created as a result of the airport operations. Table 5 illustrates the economic implications of these assumptions. The 1985 economic impact is $234,100,000 annually.

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[24]North Central Texas Council of Governments, Dallas/Fort Worth Regional Airport: Economic Impact. Arlington, Texas: NCTCOG, February 1970.

Table 4

Direct and Indirect Metropolitan Hamilton Employment Related to Airport Activity at 15% Annual Growth Rate if Mount Hope is a Full-Service D.O.T. Facility*

Date	Employees
1968	360**
1969	420
1970	480
1975	965
1980	1,940
1985	3,900

*Assumes .002490 jobs created for every enplaned passenger.
**Rounded Products.

Table 5

Economic Impact of Full-Service D.O.T. Facility at Mount Hope at 15% Annual Growth Rate*

Date	Total
1968	$ 21,600,000**
1969	25,200,000
1970	28,800,000
1975	57,800,000
1980	116,400,000
1985	234,100,000

*Assumes $60,000/job created by airport activities.
**Rounded Products.

Table 6

Direct and Indirect Metropolitan Hamilton Employment Related to Airport Activity at 15% Annual Growth Rate if Mount Hope Remains the Same*

Date	Employees
1968	55**
1969	65
1970	75
1975	150
1980	305
1985	615

*Assumes that only the Hamilton-Montreal city-pair is serviced, and that the distribution of trips to Mount Hope and Malton remains the same.
**Rounded Products.

Table 6 illustrates the number of jobs which will be created if Mount Hope does not change its current operating characteristics and levels, but air passenger traffic increases 15% per annum. In this case, 615 jobs will be generated by the airport activities. By 1985, the economic impact (Table 7) will be $36,900,000 annually. Under these assumptions, there will be a $197,200,000 "loss" annually, if Mount Hope continues to operate as it now does.

Table 6

Direct and Indirect Metropolitan Hamilton Employment Related
to Airport Activity at 15% Annual Growth Rate
If Mount Hope Remains the Same*

Date	Employees
1968	35**
1969	65
1970	75
1975	150
1980	305
1985	615

*Assumes that only the Hamilton-Montreal city-pair is serviced, and that the distribution of trips to Mount Hope and Malton remains the same.
**Rounded Products.

Table 6 illustrates the number of jobs which will be created if Mount Hope does not change its current operating characteristics and levels, but air passenger traffic increases 15% per annum. In this case, 615 jobs will be generated by the airport activities. By 1985, the economic impact (Table 7) will be $36,900,000 annually. Under these assumptions, there will be a $127,200,000 "loss" annually, if Mount Hope continues to operate as it now does.

Table 7

Economic Impact of Unaltered Mount Hope Facility
at 15% Annual Growth Rate*

Date	Total
1968	$ 3,300,000**
1969	3,900,000
1970	4,500,000
1975	9,100,000
1980	18,400,000
1985	36,900,000

* Assumes $60,000/job created by airport activities.
** Rounded Products.

Table 8

Direct and Indirect Metropolitan Hamilton Employment Related
to Airport Activity at 10% Annual Growth Rate
if Mount Hope is a Full-Service D.O.T. Facility*

Date	Employees
1968	360**
1969	400
1970	400
1975	705
1980	1,140
1985	1,835

* Assumes .002490 jobs created for every enplaned passenger.
** Rounded Products.

Table 9

Economic Impact of Full-Service D.O.T. Facility at Mount Hope at 10% Annual Growth Rate*

Date	Total
1968	$ 21,600,000**
1969	23,900,000
1970	26,300,000
1975	42,400,000
1980	68,300,000
1985	110,000,000

*Assumes $60,000/job created by airport activities.
**Rounded Products.

Table 8 illustrates the number of jobs there would be created if Mount Hope were a full-service D.O.T. facility and air passenger traffic increases 10% per annum. By 1985, 1800 new jobs would be created as a result of the airport activities. Table 9 illustrates the economic implications of these assumptions. $110,000,000 is the annual economic return.

Table 10 indicates the number of jobs which will be created if Mount Hope does not change its current operating characteristics and levels, and air passenger traffic increases 10% per annum. In this case, 290 jobs will be generated by airport activities by 1985. The economic impact, presented in Table 11, will be $17,300,000 annually. Under these assumptions, there will be a $92,700,000 annual "loss", if Mount Hope continues to operate as it now does.

Table 10

Direct and Indirect Metropolitan Hamilton Employment Related to Airport Activity at 10% Annual Growth Rate if Mount Hope Remains the Same*

Date	Employees
1968	55**
1969	65
1970	70
1975	110
1980	180
1985	290

*Assumes that only the Montreal-Hamilton city-pair is serviced, and the distribution of trips to Mount Hope and Malton remains the same.
**Rounded Products.

Table 11

Economic Impact of Unaltered Mount Hope Facility at 10% Annual Growth Rate*

Date	Total
1968	$ 3,300,000**
1969	3,800,000
1970	4,100,000
1975	6,700,000
1980	10,700,000
1985	17,300,000

Table 12

Direct and Indirect Metropolitan Hamilton Employment Related to Airport Activity at 5% Annual Growth Rate if Mount Hope is a Full-Service D.O.T. Facility*

Date	Employees
1968	360**
1969	380
1970	400
1975	510
1980	650
1985	830

Table 13

Economic Impact of Full-Service D.O.T. Facility at Mount Hope at 5% Annual Growth Rate*

Date	Total
1968	$21,600,000**
1969	22,900,000
1970	24,000,000
1975	30,600,000
1980	39,100,000
1985	49,900,000

*Assumes $60,000/job created by airport activities.
**Rounded products.

Table 14

Direct and Indirect Metropolitan Hamilton Employment Related to Airport Activity at 5% Annual Growth Rate if Mount Hope Remains the Same*

Date	Employees
1968	55**
1969	60
1970	65
1975	80
1980	105
1985	130

*Assumes that only the Montreal-Hamilton city-pair is serviced, and the distribution of trips to Mount Hope and Malton remains the same.
**Rounded Products.

Table 15

Economic Impact of Unaltered Mount Hope Facility at 5% Annual Growth Rate*

Date	Total
1968	$3,300,000**
1969	3,600,000
1970	3,800,000
1975	4,900,000
1980	6,200,000
1985	7,900,000

*Assumes $60,000/job created by airport activities.
**Rounded Products.

Table 12 presents the number of jobs that would be created if Mount Hope were a full-service D.O.T. facility and air passenger traffic increases 5% per annum. The table indicates that 830 new jobs would be created, by 1985, as a result of airport operations. Table 13 presents the economic implications of these assumptions. The annual return is $49,900,000 by 1985.

Table 14 indicates that 130 jobs which will be created if Mount Hope does not change its current operating characteristics and levels, and there is a 5% annual growth in air passenger traffic. The economic impact of this situation is presented in Table 15. The annual return is $7,900,000 by 1985. Under these assumptions, there will be a $42,000,000 annual "loss", if Mount Hope continues to operate as it now does.

Summary and Conclusions

This section of the study has demonstrated, granting certain simplifying assumptions, that:

(1) Metropolitan Hamilton can currently support a full-service D.O.T. facility.

(2) Such a facility should provide substantial relief for Toronto International Airport.

(3) Metropolitan Hamilton will easily support a full-service facility in the future.

(4) Airports have a significant employment and economic impact.

CASE STUDIES OF AIRPORT IMPACT

The general variety of regional commercial and industrial blends and the concommitant occupational mix renders any generalization regarding the economic impact of airports somewhat suspect. Nevertheless, not in an effort to reason by analogy, but rather to produce some broad general conclusions about this subject, this report will review a number of pertinent examples.

Toronto International

More than thirty years ago Malton was picked as the site of the new Toronto airport. The reaction of most Torontonians was incredulity -- "It might as well be in Moosonee", "A whole day's journey there and back," and so on. Today, Toronto International airport is 2.0 miles from the population centre of gravity of the Toronto centred region. It is surrounded by not only extensive housing developments but also a complex of interrelated secondary manufacturing establishments and the tertiary industries which service them and their employees. Cause and effect? Not truly, one supposes, but to some extent the industry/airport relationship has clearly been symbiotic. Nothing, after all, inhibits the industrial and commercial development of the eastern approaches to Toronto yet they remain largely undeveloped rural areas or bedroom communities.

Portland, Oregon

This case is interesting for two principal reasons. First, with air traffic and passenger potential less than that which this report has conservatively assessed for Hamilton, in 1964 Portland undertook an extensive alteration of its existing

airport facilities, developing runways, improving navigation aids, and building new passenger facilities. Second, Portland airport was extraordinary, in that no major through highway passed near the airport and the surrounding area was mainly undeveloped. Since then, controlled land use plans have channeled the rapid growth in demand for motel locations, plant sites, etc., into an attractive commercial and residential development complementary to the airport.

Lincoln, Rhode Island

Several years ago, the State of Rhode Island developed, and is continually improving, the North Central State Airport at Lincoln. Property acquired in connection with airport development was extensive, reflecting the State's vision for positive protection of the airport and for attraction of desirable non-airport development in the area. In a report published by the State in December 1961, it was recommended that this land could possibly be utilized for industrial purposes.

The Pawtucket-Blackstone Valley Chamber of Commerce suggested to the Governor that a study be conducted to determine the site's industrial development feasibility in order to place undeveloped land into productive use. In the summer of 1962, a consultant was engaged by the above mentioned Chamber of Commerce, the Town of Lincoln, and the State of Rhode Island to prepare such a feasibility study. Although the airport was adjacent to this parcel of land and was recognized as being of some possible utility in connection with an industrial park, the apparently attractive feature of the area was its advantageous location with respect to the existing and proposed highway system.

The State Aviation Officials of Rhode Island had been trying for a number of years to foster industrial development around its state-owned airports on the basis of the advantages which could accrue from the relationship between the airport and industry. The reception by the communities, while favorable, did not lead to any fruitful results because they could not see the advantages to their economy.

In May of 1962, the first editions of the FAA study entitled "General Aviation and Its Relationship to Industry and the Community" was published and distributed to various states and aviation groups. This study proved to be a catalyst which placed an entirely new perspective on the industry/aviation picture in Rhode Island. The concept of an industrial park at Lincoln changed from one which focused primarily upon the advantages of adjacent highway facilities to one of an industrial air-park complex. It was quickly observed that industry placed a definite reliance on air transportation, among other things, in conduct of its business. With this thought, the Rhode Island Officials and their consultants undertook thorough preplanning of the entire industrial air park concept for Lincoln, resulting in a functional marriage between the airport and the industrial park.

Hayward, California

Mr. Leigh Fisher who, as the head of Leigh Fisher Associates, has for years been recognized as a leading authority on airport development matters, is president of a new corporation, known as Airport Investors and Developers, Inc. With Hayward airport as a nucleus, his plan calls for the long term development of four basic areas, which will result in an industry/business/community centre.

It will contain an 18 hole golf course, a commercial area, an apartment zone and an industrial park, surrounding an excellent airport. All land will be publicly owned and development will be by private capital under leasehold arrangements. It is anticipated that this method of bringing private property management practices and financing flexibility to public airport development will prove to be a model for other communities. Improvements to land under the plan are expected to add up to 16 million dollars to the City's land values, and to bring a profitable cash return from the airport enterprise which could total over $1,000,000 a year after 10 years. Additionally, it is estimated that some 1,200 new jobs will be created adding 10 million dollars to the local payroll.

It is important that a venture of this type be compatible with the community. To assure this, the development has been carefully master planned, and construction must comply with land use and height restriction zoning.

To the professional or businessman, the development will be a garden type office building. To the local retailer, it will be a modern shopping and hotel centre. To the home-seeker, it will be 17 acres of fine apartments. To the industrial executive, it will be an ideally located plant site and distribution centre. To all, it will prove convenient road, rail and air transportation.

Islip, Long Island, New York

The Town of Islip, Long Island is actively promoting industrial development to provide economic stability for the area. In such promotion, the MacArthur Airport has a vital role. It is surrounded by over 2,000 acres of industrial

property, forming a buffer zone against residential development. Since 1959, 9 firms, employing over 3,500 persons, have constructed facilities and one additional firm is currently constructing a plant adjacent to the airport. In addition to these off-airport uses, approximately 1,200 persons are employed by industries located directly on the field. The contribution of MacArthur Airport to the community is more clearly understood when analyzed in terms of total new industry and jobs it has helped to create. This airport based industry will mean approximately 2,000 new jobs, 19 million dollars more personal income, 30 additional retail establishments and 12 million dollars more retail sales per year. In residential tax relief revenue, this additional industry will contribute approximately 125 thousand dollars.

Pittsburgh, Pennsylvania

In many respects Pittsburgh's situation is analogous to Hamilton. It is a steel centre. It is located at the midpoint of a nearly continuous belt of industrial communities stretching from New York to Washington. It serves a mixed agricultural-residential hinterland. The industrial tax base of the City is not growing as rapidly as the United States in total. The topography of Allegheny county is such that there are very few areas available for the development of airports. Pittsburgh has an airport -- one of the busiest in the United States, partly by virtue of its central location and partly because it is a very large community with a highly developed and diversified economy. Greater Pittsburgh air-

port will become an international airport in 1971. This facility is expected to have a significant economic inpact on Pittsburgh and the surrounding counties in the next ten years.

From the standpoint of providing a base for air transportation, the lack of substantial absolute growth of the economy of the Pittsburgh Metropolitan Area has been offset by significant developments in research and corporate administrative activities in the area. Research and corporate administrative activities have been found to generate greater air traffic volumes than do manufacturing and retail sales activities in terms of their respective total employments. Research and corporate administrative activities have a higher ratio of professional employees to total employees than do most other activities and professional employees and, as a group, make a greater number of air trips than do most other employee groups.

In this connection, a survey conducted for American Airlines discerned the following air travel pattern for the U.S.A. in general.

EXHIBIT 2: Air Travelers

	Air Total	Heavy	Occasionally	Light	Former Air Travelers	Not Flown But Travel
	%	%	%	%	%	%
Manufacturing	41	49	39	37	34	38
Retail	18	15	16	21	17	21
Professions	18	20	19	17	16	12
Personal Service	5	3	8	5	6	8
Government	7	7	9	5	12	6
Communications	4	4	4	5	2	3
Transportation	5	2	3	7	9	10
Military	2	-	2	3	4	2

Source: The Auto Jet

Thus it becomes apparent that manufacturing companies are the largest users of air travel. The same conclusions can probably be generalized for Canada.

EXHIBIT 2: VIA Intercity

OTHER CASE STUDIES AND RESEARCH

In a study conducted by the H. O. Walter Company, Real Estate Appraisers and Consultants of Chicago, covering twelve years and over 800 transactions of residential property within a mile of the Chicago, Dallas, Denver, Los Angeles, Newark, and LaGuardia airports as compared with comparable homes in neighbourhoods entirely removed from airports, it was found that there appeared to be no appreciable difference in the market behaviour of property affected by airports. The property in airport areas increased in value at the same rate, or even faster than property in other areas. Also, there appears to be no appreciable differences in the market behaviour of homes located in the approach and departure zones of the airports as compared with those located outside of those highly critical noise areas. None of the real estate men who handled property in airport areas felt the values were adversely affected by the location. It was concluded that the advantages of the airport more than offset any adverse influences on property values.

Mr. Walter concluded that, in view of his study, airports tend to increase general real estate activity and have no adverse effect upon the value of residential property in the vicinity of airports. This does not mean that construction of homes should be encouraged in critical noise areas, but it does indicate that the homes already there will not lose their value at a greater rate than a comparable home in another area.

In 1962, Leigh Fisher cited a new trend that was developing in commercial and industrial site locations. He indicated that office buildings, industrial plants and warehouses located within airport property were obtaining an increasing share of new construction activity. He further indicated that many industrial realtors felt that airport-oriented industrial and commercial complexes might have as great an impact on future industrial-business location patterns as shopping centers have had on the retail field.

This trend for industry to locate on or near airport property has since been substantiated by several studies conducted by the Airports Division of the Eastern Region of FAA, as well as by other surveys that have been conducted by other research and/or industrial site specialists.

In 1966, the Texas State Aeronautics Commission completed a comprehensive survey of 300 communities. This survey received about two-thirds response on the questionnaire. The purpose was to determine attitudes of individual communities toward the relationship between community growth and airports. The response indicates that unanimity was expressed by virtually all the responding representatives that adequate landing facilities are required for modern-day community growth. Several cases were cited where industry has chosen to locate in a community because of an airport, or conversely, had chosen to locate elsewhere because airport facilities were lacking.

The Tri-State Transportation Committee issued a report in 1966 recommending the establishment of a regional system of thirty-two airports in the metropolitan

New York area. This system would be for nonmilitary and noncommon carrier aircraft. The Committee -- an eighteen member group of public works and planning employees of the states of Connecticut, New Jersey, and New York -- emphasized the importance of general aviation to the growth of the Tri-State area. They noted that over eight per cent of persons travelling via general aviation were executives or key professional personnel. The Committee indicates that the thirty-two airport system should be situated in such a manner that every part of the tri-state metropolitan region would be no more than thirty minutes (automobile travel time) from one of the landing fields.

The Minneapolis - St. Paul Metropolitan Airports Commission developed an integrated system of six airports to provide the necessary air transportation facilities for the Twin City metropolitan area. The system is a suburban ring of airports, all under the control of MAC. This system is designed to serve the business and executive air travel to the metropolitan area. It provides all-weather, year-around facilities. The result is increased aircraft utilization, more rapid and easier access to and from the facilities, greater traffic and service capabilities, and decentralization of air traffic providing a safer, more efficient operation. The TIA I-Mount Hope comparison is obvious.

In California an extensive report conducted under the auspices of the Senate Fact Finding Committee on Transportation and Public Utilities and the Assembly Interim Committee on Transportation and Commerce determined the need for the development of a statewide system of airports. The report further found

that every effort should be made to preserve, protect, and encourage the existing private airports which serve the public. But, it appears that private ownership of public airports is becoming, or has become, economically unfeasible and only public ownership can be expected to provide the needed facilities in the near future.

In a recent (1969) FAA study entitled, "The Airport -- Its Influence on Community Economy", several airports were surveyed in a variety of communities. At each location, community leaders considered the airport to be an important factor in balanced community development. Other findings of the study are summarized as follows:

a. Airport development is a catalyst for business and industrial growth.

b. The airport is an attraction for new industry.

c. An airport can be a factor in retaining existing business and industry.

d. Industrial expansion furnishes employment for surplus farm labour.

e. Air transportation is an aid to industrial equipment maintenance programs.

f. The airport provides access to the national air transportation system.

g. Realization of benefits from airport development requires adequate lead time.

h. The airport provides agricultural services to mechanized farms.

i. The airport can be a nucleus for industrial concentration.

SUMMARY AND CONCLUSIONS

The report reviews the development of airports in general, and Hamilton municipal airport in particular. It is shown that the Hamilton municipal airport has exhibited a development pattern consistent with the general North American experience. The study reviews the current status of the Hamilton air passenger demand and facilities. It is found that: (1) the Hamilton Metropolitan area currently generates a substantial domestic air passenger traffic, representing approximately 17% of Toronto International Airport's current air passenger traffic, (2) Mount Hope Airport is one of the busiest airports in Canada in terms of aircraft operations, and (3) Nordair is successfully operating daily service between Mount Hope and Montreal.

The report reviews the implications of a proposed expansion of Mount Hope to a full-service regional airport. It is found that:

1. Current domestic user demand can support a full-service regional airport.
2. Such a facility will provide substantial relief from Toronto International Airport.
3. Future demand will easily support a full-service regional airport.
4. A full-service regional airport will have a substantial economic impact on the Hamilton Metropolitan area.
5. Expansion of the Mount Hope facilities to a full-service regional airport will have little or no deleterious affect upon surrounding land uses.

In conclusion, large aircraft mean long runways which mean big airports. This all means an extensive demand for land. New airports are pushed farther and farther away from the cities they serve because suburbs absorb the usable land. Long city-to-airport travel is time consuming. When this time greatly exceeds the time required to reach a rail or bus station, then aviation's competitive advantage suffers. This is because most air passenger traffic is short haul -- over one half of all passenger trips are less than 500 miles.

Even when the new noise contour guide is imposed on many existing airports, no severe hardship will occur -- particularly when it is recognized that land abutting an airport can become tremendously attractive for commercial and industrial enterprise when properly planned and controlled for complementary uses. From a planners' point of view, an airline airport should be considered a major employment centre. Secondary airports also have the same possibility. Each should be surrounded with a compatible arrangement of landscaping, industrial and commercial uses, and residential properties situated such as to be minimally affected by aircraft noise and operation. With a compatible land use pattern, noise suppression by distance, terrain, foliage and structural attenuation, and reflection would be maximized.

Air transportation is now the accepted medium of commerce and communication. Most businessmen want to live in easy reach of an airport to ease their personal travel burden; they want their offices near an airport to make their business operations more efficient; and almost without exception, businessmen recognize that

being reasonably close to a major airline airport, and/or adequate general aviation facility, assures a continued high value for both their personal and business property.

While there has been much talk to the contrary, value of land near major airline airports has been soaring. Where values were measured in terms of dollars per acre a few years ago, today they are measured in dollars per square foot in many places. This growth in property values has occurred because business has been moving to the airport environs and the business centre nature of the airports is recognized. The pace of today's business and commerce is forcing the airports to become "downtowns".

The airport is just a new land use fully capable of being properly integrated into an intelligent regional plan. The impact of an airport is the same as that of any other major transportation facility -- it generates employment, population, commerce, and business. If properly used, an airport can be the stimulus for an area's development and increasing of land values and employment opportunities in the airport area. The modern airport is a new type of land use, and has many problems unforseen in the past. It cannot be located or zoned on a segregated basis of regional planning. It must be integrated with the land use and community plans on a performance basis. The airport will have a beneficial impact if it is planned for.

APPENDIX

The 100 CNR (Composite Noise Rating) contours are shown for the proposed Mount Hope airport in Figures 1 and 2. Figure 1, for example, shows the 100 CNR contours drawn for both daytime and nighttime operations as a result of aircraft taking off and landing from the runways oriented in the 290° directions. (The traffic patterns for all runways are as shown in Table A.) The difference in the size of the 100 CNR contours is due to the effect of percent utilization of the runway, the time of day, the frequency of operations and of course the type of aircraft. Table A also lists the correction factors which account for the above effects. The correction factor and primary CNR contour have been taken from Reference 4.

Figure 2 describes the 100 CNR contours for the same type of aircraft taking off in the opposite directions, the runways can now be labelled 110°. Figure 2 also shows the 100 CNR contours for take offs and landings of the smaller turbo-jet and turbo-fan aircraft (of the size of the Boeing 737's and the Douglas DC-9s) on runway 060°, once again assuming a traffic pattern as shown in Table A. The contour can easily be rotated through 180° to show typical 100 CNR contours for the same runway in the 240° direction.

TABLE A

unway irection	Time Of Day	Traffic	Correction* Take Off	Correction* Landing
290°	0700-2200	4 engine > 2000 miles		
		3 take offs and landings/period	-5db	-5db
		% utilization of runway (>31%)	0db	0db
		time of day	0db	0db
		correction for turbo-fan	-5db	0db
		Total Correction	-10db	-5db
290°	2200-0700	4 engine > 2000 miles		
		3 take offs and landings/period	-5db	-5db
		% utilization (>31%)	0db	0db
		time of day	+10db	+10db
		correction for turbo-fan	-5db	0db
		Total Correction	0db	+5db
110°	0700-2200	4 engine > 2000 miles		
		3 take offs and landings/period	-5db	-5db
		% utilization (10-30%)	-5db	-5db
		time of day	0db	0db
		correction for turbo-fan	-5db	0db
		Total Correction	-15db	-10db
060°	0700-2200	2 engine < 2000 miles		
		e.g. B-737, DC-9, etc.,	-3db	-3db
		6 take offs and 6 landings/period	-5db	-5db
		% utilization (>31%)	0db	0db
		time of day	0db	0db
		correction for turbo-fan	0db	0db
		Total Correction	-8db	-8db

*Note: All corrections applied to the 100 CNR contours as given in Ref. 4. The corrections provide a more realistic set of 100 CNR contours based on proposed size of aircraft, period of operation and percentage utilization of runways.

TABLE A-

FIGURE 1

EXPLANATION OF CNR CONTOURS

RUNWAYS 29 IN DIRECTION OF ARROW:

A - TAKE OFF, 4 ENG. > 2000 MILE DAY (0700-2200)

B - LANDING, 4 ENG. > 2000 MILE DAY (0700-2200)

C - TAKE OFF, 4 ENG. > 2000 MILE NIGHT (2200-0700)

D - LANDING, 4 ENG. > 2000 MILE NIGHT (2200-0700)

FIGURE 2

EXPLANATION OF CNR CONTOURS

RUNWAY 06 IN DIRECTION OF ARROW:

E - TAKE OFF, B 737 DAY (0700-2200)

F - LANDING, B 737 DAY (0700-2200)

RUNWAYS 29 IN DIRECTION OF ARROW:

G - TAKE OFF, 4 ENG. > 2000 MILE DAY (0700-2200)

H - LANDING, 4 ENG. > 2000 MILE DAY (0700-2200)

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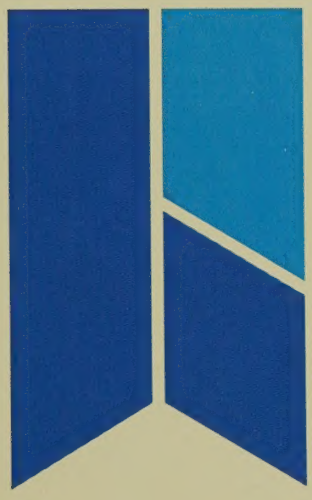

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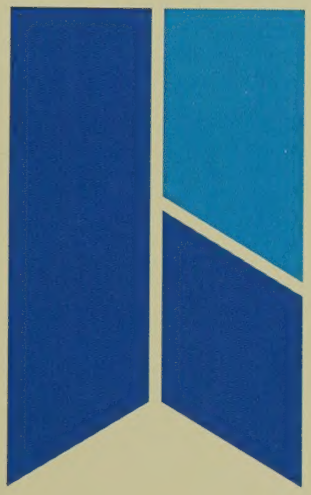

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